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AIR FORCE SPECIAL WEAPONS CENTER
Air Force Systems Command
Kirtland Air Force Base
New Mexico

TECHNICAL REPORT NO. AFSWC-TR-69-8

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PREPRODUCTION TESTS OF THE BDU-41/B PRACTICE BOMB

Robert G. Simon

TECHNICAL REPORT NO. AFSWC-TR-69-8

FOREWORD

This report was prepared under Program Element 6.44.15.03.F, Project 5708, Task 57081. Lt R. M. Keefer, WLDM, was the Air Force Weapons Laboratory Project Officer.

Inclusive dates of testing were 24 November 1967 to 2 June 1968. The report was submitted 23 April 1969 by the Air Force Special Weapons Center Test Director, Mr. Robert G. Simon (SWTEE).

Information in this report is embargoed under the Department of State ITIARs. This report may be released to foreign governments by departments or agencies of the U.S. Government subject to approval of AFSWC (SWTEE).

This report has been reviewed and is approved.

Robert G. Simon

ROBERT G. SIMON
Test Director

Oscar E. Hopkins Jr.

OSCAR E. HOPKINS, JR.
Chief, Systems Engineering Division

David E. Chadwick

DAVID E. CHADWICK, Technical Advisor
Director of Test & Engineering

AG Swan

A. G. SWAN, Colonel, USAF
Director of Test & Engineering

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SECTION I

TEST REQUIREMENTS

To determine that design of the BDU-41/B (figure 1) is satisfactory for large-scale production, the Air Force Weapons Laboratory requested the Air Force Special Weapons Center to subject a prototype BDU-41/B to measurements and tests according to the following specifications:

1. Weight, pitch, and roll moment of inertia, and center of gravity measurements.

2. High temperature test on exterior surfaces at 418°F for 20 minutes at the nose and leading edges of fins and 300°F for 20 minutes at all other surfaces.

3. Low temperature test in accordance with MIL-STD-810A, Method 502, Procedure 1.

4. Shock test in accordance with MIL-STD-810A, Method 516, Procedure 1.

5. Vibration test in accordance with MIL-STD-810A, Method 514, Figure 514-1.

6. Humidity test in accordance with MIL-STD-810A, Method 507, Procedure 1.

7. Salt fog test in accordance with MIL-STD-810A, Method 509, Procedure 1.

8. Sand and dust test in accordance with MIL-STD-810A, Method 510, Procedure 1.

9. Static Load Tests

   a. Longitudinal parachute opening load of 120,000 pounds applied statically through the suspension line support points, the load to be applied in 10 percent increments until failure occurs or the maximum load of 120,000 pounds was obtained.

   b. Bomb static load lug tests, with vertical, axial, and side loads applied simultaneously, as follows:

Figure 1. BDU-41/B

	Vertical lb	Axial lb	Side lb
Forward 30-inch lug	23,025	5,115	2,235
	15,780	3,735	10,770
Aft 30-inch lug	26,205	1,185	2,475
	0	5,115	9,900

These loads represent 150 percent of design loads.

c. Fin and tail section to be tested by application of a 2200-pound load to each of two fins at station 123.11 and 3.35 inches from the bomb skin. The loads to be applied simultaneously, one clockwise and one counterclockwise, with the bomb restrained at the preflight and/or center section.

10. Tail cap separation tests to be conducted to determine tail cap separation characteristics.

SECTION II

TEST RESULTS

1. The BDU-41/B was weighed on two Toledo Platform Scales, Model No. 2181, 400-pound capacity. The bomb was supported on the scales at two carefully measured stations. Thus, total weight and center of gravity location were obtained. Total weight was 727 pounds, 11 ounces; center of gravity was located at station 60.10. The moment-of-inertia measurement was made using a calibrated torsional pendulum with provisions for timing the period of oscillation. The pitch moment of inertia of the BDU-41/B was found to be 1,116,113 lb-in^2 and the roll moment of inertia was 17,552 lb-in^2.

2. The high temperature test could not be accomplished as requested since no heat source was available which would give either the desired temperatures or the desired heating rates. A lesser test was substituted in which a custom-built chamber, with the BDU-41/B installed (figure 2), was heated from room temperature to 300°F in 3 hours and held for 20 minutes at 300° $\pm$ 10°F.

No damage to the bomb was observed as a result of this test.

3. The low temperature was performed, as specified, at -80°F for 48 hours. Visual inspection of the BDU-41/B did not reveal damage following this test.

4. The shock test was done by mounting the BDU-41/B on a large pivoted drop device (figure 3). Although this device does not yield the desired waveform, the desired shock level was attained.

The bomb was attached to an MAU-12B/A rack which in turn was mounted to the drop device. Mounting orientation was changed to obtain shocks in the required six directions. The bomb was shocked at least three times in each direction of the three major axes (18 or more shocks). Figures 4 through 9 show representative shock waveforms.

The shock test had no reportable effects on the BDU-41/B.

5. The vibration test was conducted with input levels as required by curve B of figure 514-1, MIL-STD-810A, except that vibration could not be applied below 14 cps.

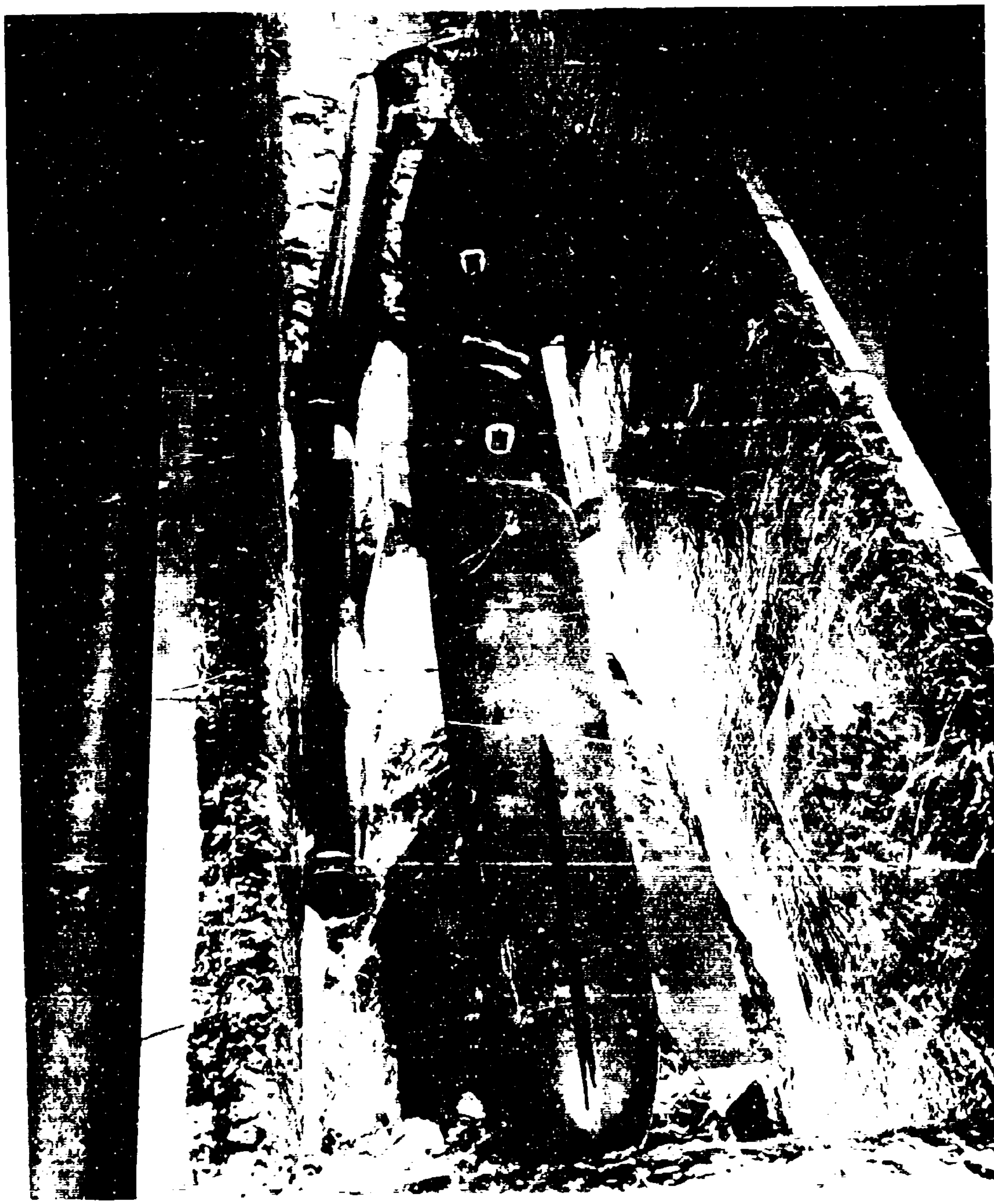

Figure 2. High Temperature Test

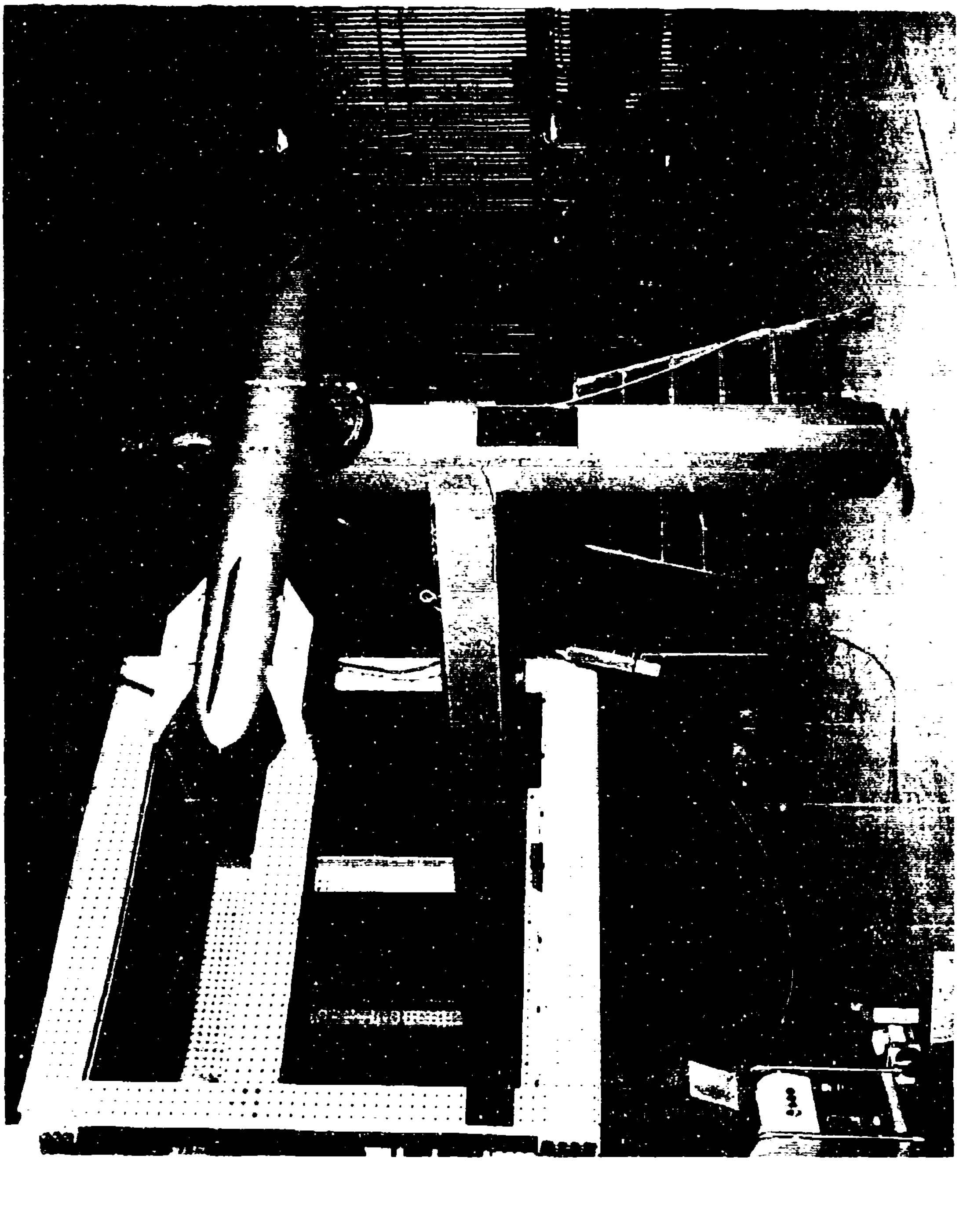

Figure 3. Shock Test Setup

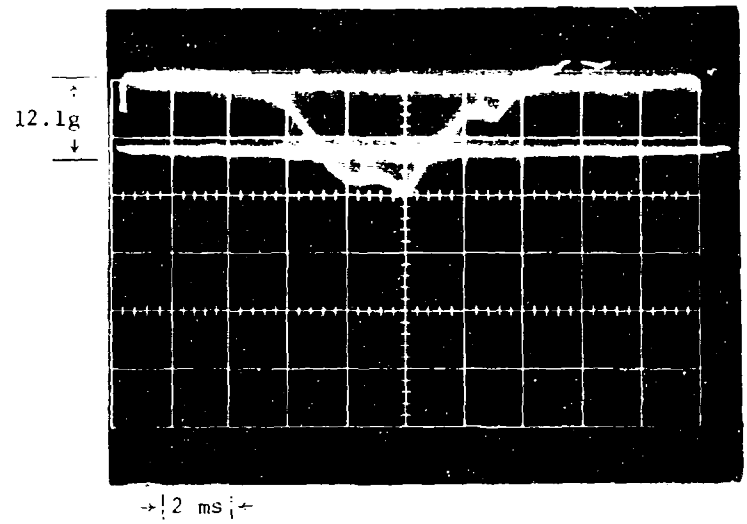

Figure 4. Shock Input
Longitudinal Rearward

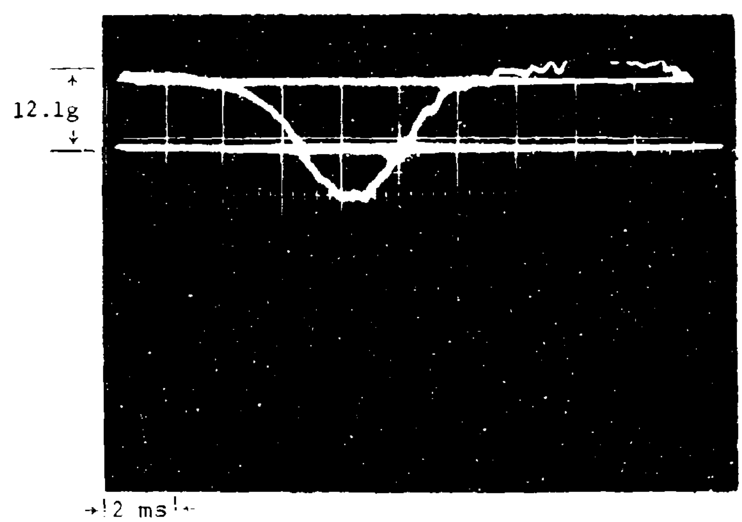

Figure 5. Shock Input
Longitudinal Forward

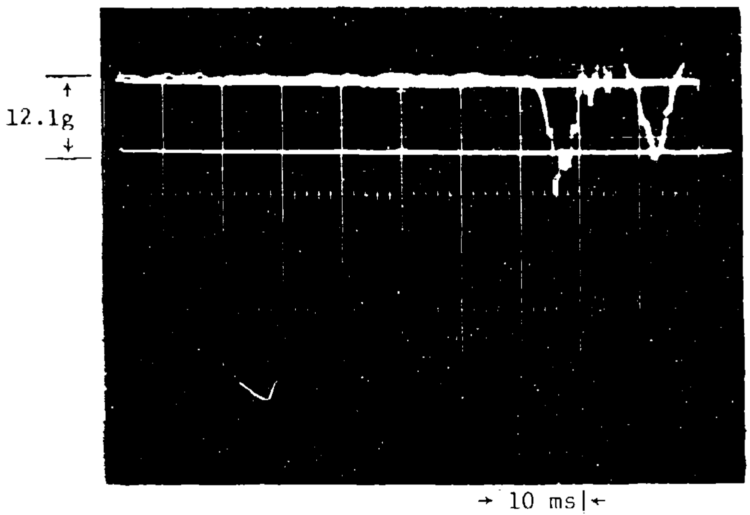

Figure 6. Shock Input
Lateral to Left

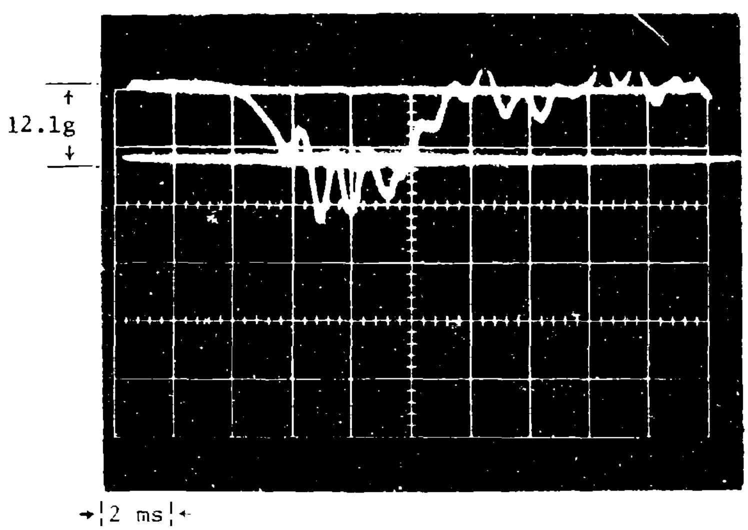

Figure 7. Shock Input
Lateral to Right

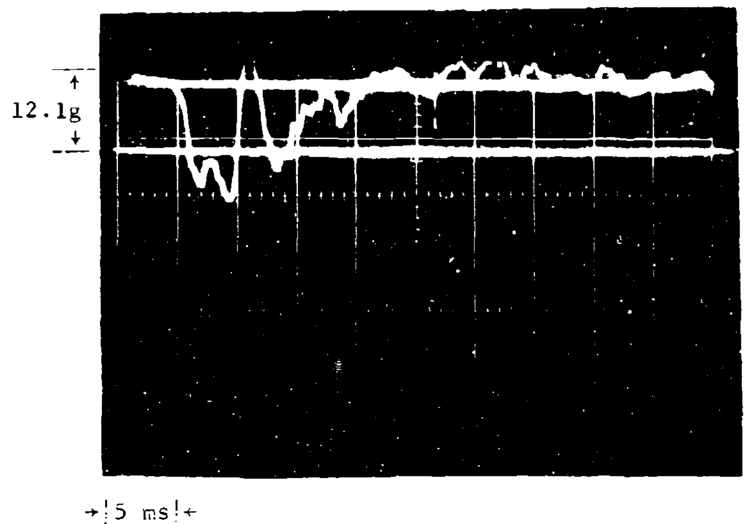

Figure 8. Shock Input
Vertical Downward

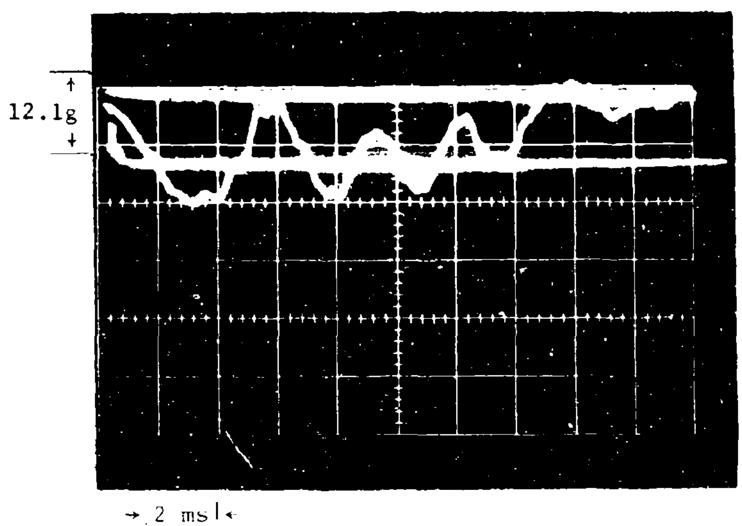

Figure 9. Shock Input
Vertical Upward

The frequency range of 14-500 cps was swept logarithmically in 6 minutes as required by Time Schedule 1 of Table 514-11.

Vibration was applied through an MAU-12B/A bomb rack. Input amplitude was measured on the rack. Response of the bomb was measured by shifting a transducer to various locations during the tests.

For the vertical axis vibration, the rack and bomb assembly was mounted to the shaker head (figure 10). For longitudinal and lateral vibration, the rack and bomb assembly was mounted to a horizontal oil-supported plate which, in turn, was joined to the shaker head (figure 11).

Vertical vibration was done first, followed by lateral, then longitudinal.

Just after the start of the vertical vibration, the control feedback accelerometer mounting failed, causing extremely high momentary acceleration input to the test item. No visible damage to the bomb resulted from this failure.

The vertical test consisted of 1-1/2 hours cycling time and 30 minutes at each resonant frequency of 48, 210, and 318 cps. Post-test examination did not reveal damage to the bomb.

The lateral test consisted of 2 hours cycling time and 30 minutes at each resonant frequency of 82 and 136 cps. No damage to the bomb was observed as a result of this test.

Longitudinal vibration caused severe rattling at the junctions of the MAU-12B/A rack and the BDU-41/B bomb. Fifty minutes of sweep was followed by 30 minutes dwell at 76 cps. During this dwell, resonant amplitude at the junction of the center and tail sections decreased from 28g to 10g, with the frequency held constant. Since a change of this nature usually denotes a change in structural integrity, vibration was stopped for examination of the test setup. It was found that all four sway brace pads of the MAU-12B/A bomb rack were broken (figure 12) but had remained in place. Marks on the bomb showed that slippage between the pads and the bomb was approximately 3/32 inch in each direction from rest position.

The bomb was then disassembled for examination. Wear marks on the parachute can (figure 13) showed that the parachute had been moving in the can and that the can had been moving in the bomb tail section. Bolts intended to hold the parachute can to the tail section had pulled out of the parachute can.

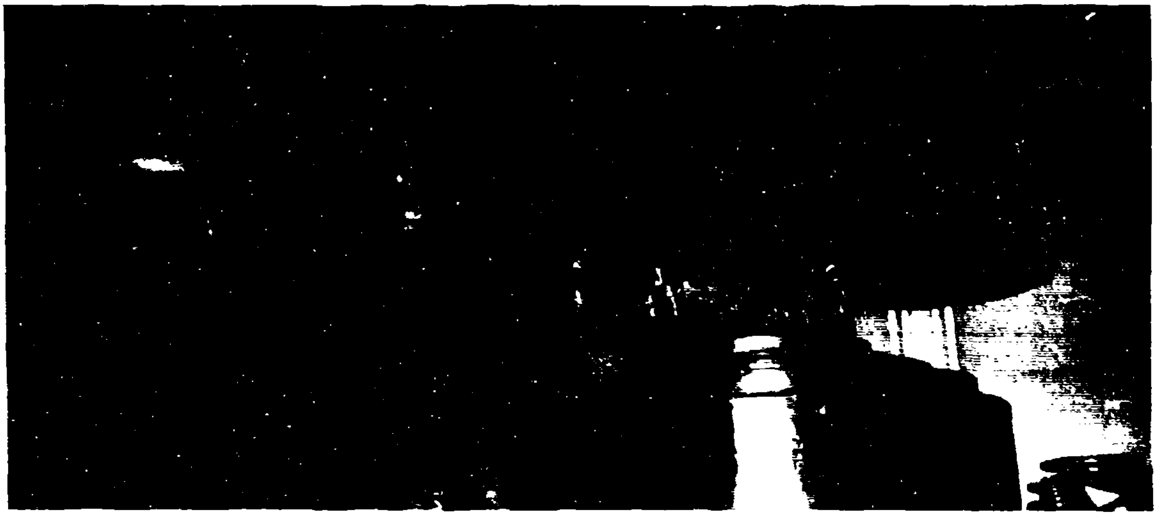

Figure 10. Vibration Setup
Vertical Axis

Figure 11. Vibration Setup
Longitudinal and Lateral

Figure 12. Broken Sway Brace Pad

Figure 13. Parachute Can Wear Marks

The vibration test was discontinued, pending redesign of components of the tail section.

Damage had not affected parts which were to be static tested.

6. The humidity test resulted in minor rusting of unpainted portions of the bomb, including mating surfaces of the bomb sections. The tail fins were removed for test because of space limitations of the chamber, and were not included in the test.

7. Exposure to the salt fog environment further rusted unprotected metal surfaces of the bomb body. No effect on the tail fins was observed.

8. Sand and dust testing could not be done because a chamber of the necessary size was not available.

9. Static load tests were performed using hydraulic cylinders and strain gage load cells.

a. Lugs were tested using an adaptor at the lug (figure 14). Loads were applied in 10 percent increments with an extra increment at 66-2/3 percent, which represents 100 percent of the design loads. No damage to the lugs resulted from these tests.

b. Tail fins were tested by applying loads to both fins simultaneously from a single source (figure 15). Dial gages to measure fin deflection were mounted to a third, unstressed, fin. Loads were applied three times to obtain a pure load test. The table below lists load versus deflection for these tests. Designation of right and left fins is as observed from aft of the bomb looking forward.

c. Parachute opening load (figure 16) was applied twice in 10 percent increments to the full 120,000-pound level without failure.

10. The tail cap separation tests were omitted at the request of the AFWL project officer.

11. The repeat shock tests of the bomb with a redesigned tail section were performed because of the earlier failure in vibration. During the forward longitudinal shock, the tail cap became dislodged but did not separate from the bomb (figure 17). At the request of the AFWL project officer, the tail cap was retightened and the tests completed. No further difficulty was experienced and no other damage to the bomb caused by these tests was observed.

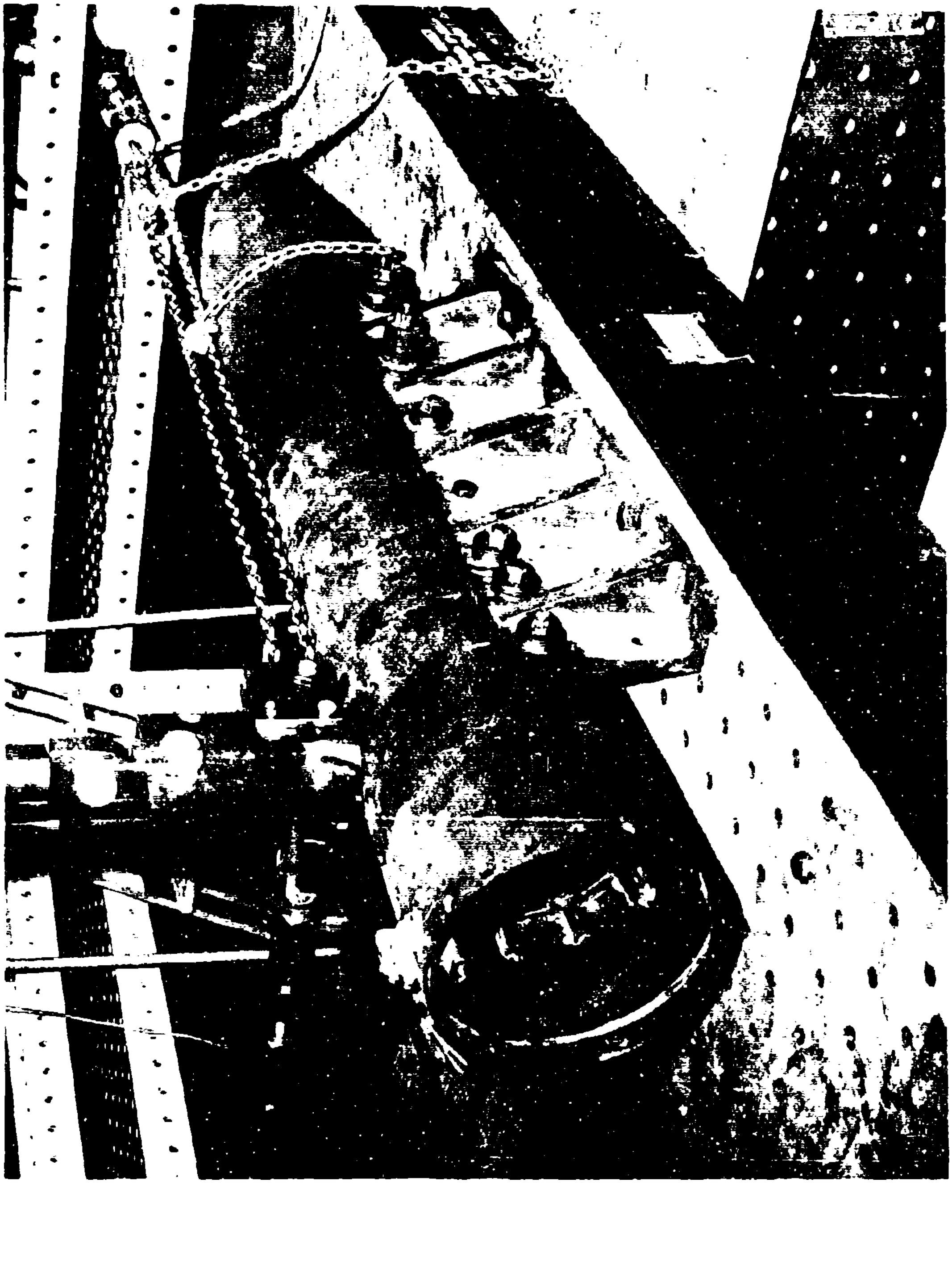

Figure 14. Lug Static Load Test

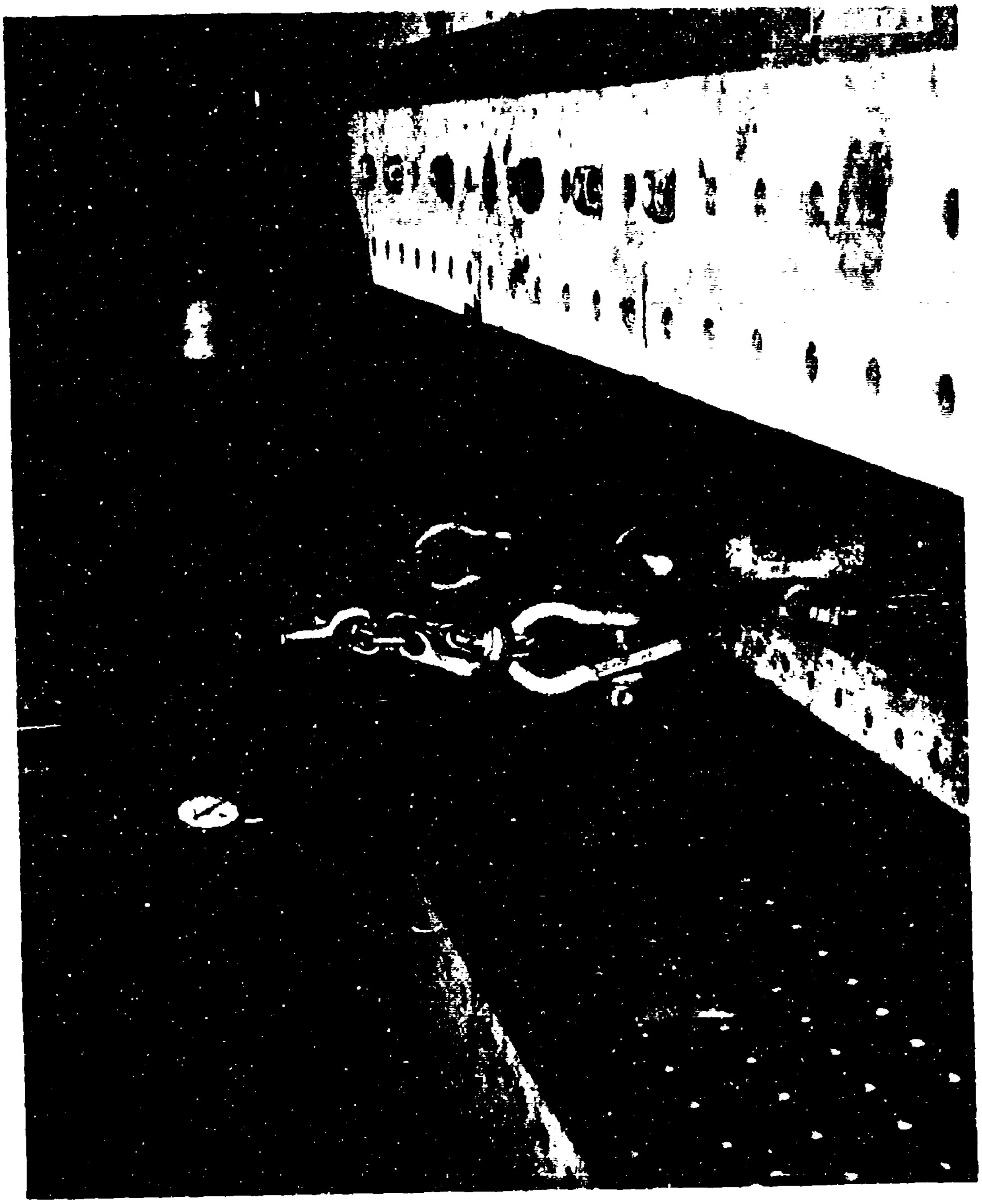

Figure 15. Tail Fin Static Load Test

TABLE

TAIL FIN LOAD VERSUS DEFLECTION

Load per Tail Fin (lb)	DEFLECTION (in.)					
	Load Cycle 1		Load Cycle 2		Load Cycle 3	
	Left Fin	Right Fin	Left Fin	Right Fin	Left Fin	Right Fin
0	0	0	.023	.027	.022	.026
250	.007	.002	.029	.026	.030	.027
500	.019	.008	.041	.029	.041	.028
750	.033	.013	.049	.032	.050	.033
1000	.037	.019	.058	.037	.059	.038
1250	.046	.026	.067	.044	.068	.045
1500	.057	.038	.076	.053	.078	.054
1750	.076	.052	.086	.061	.087	.063
2000	.092	.064	.095	.068	.097	.070
2200	.103	.073	.104	.075	.104	.077
0	.023	.027	.022	.026	.023	.026

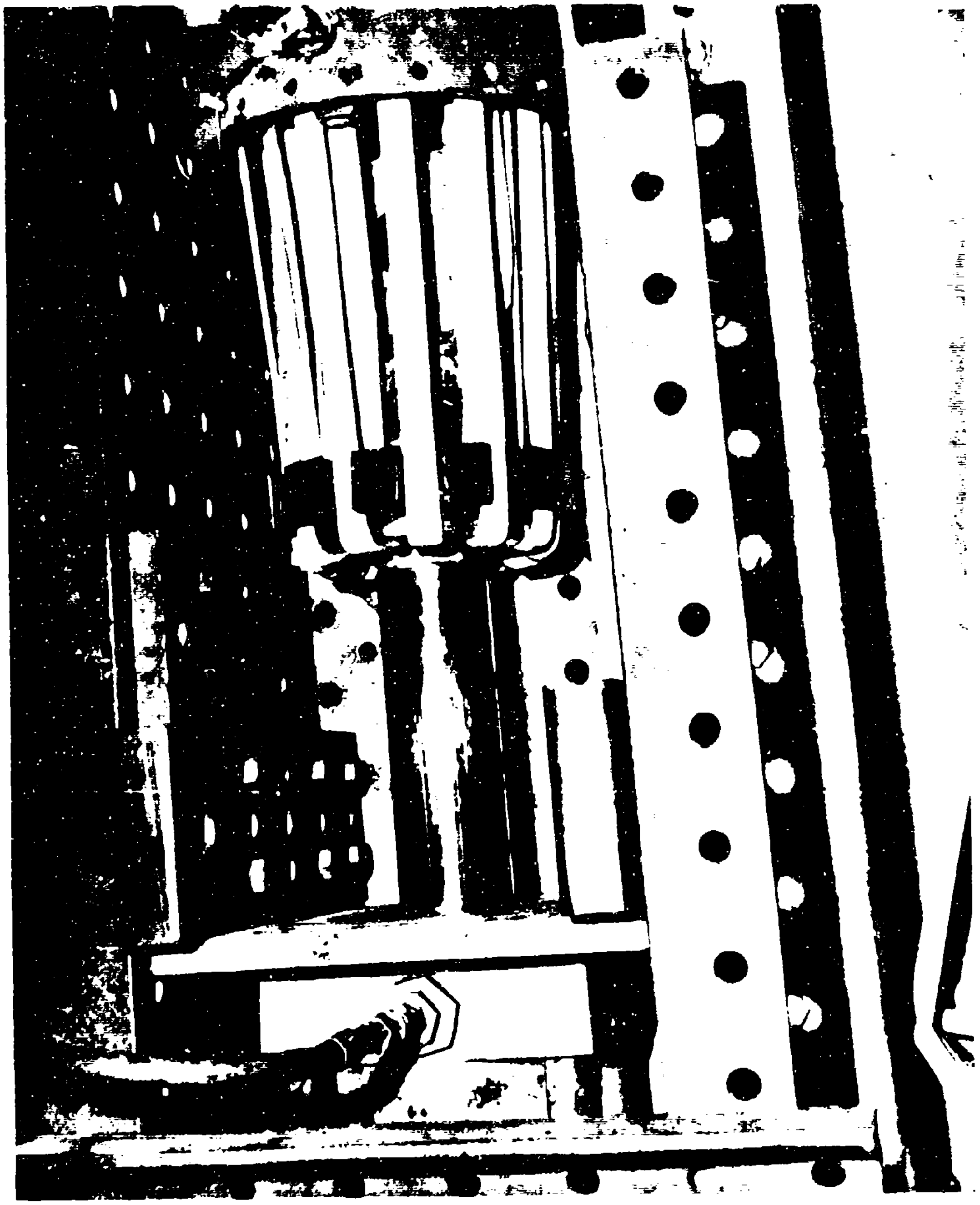

Figure 16. Parachute Opening Load Test Setup

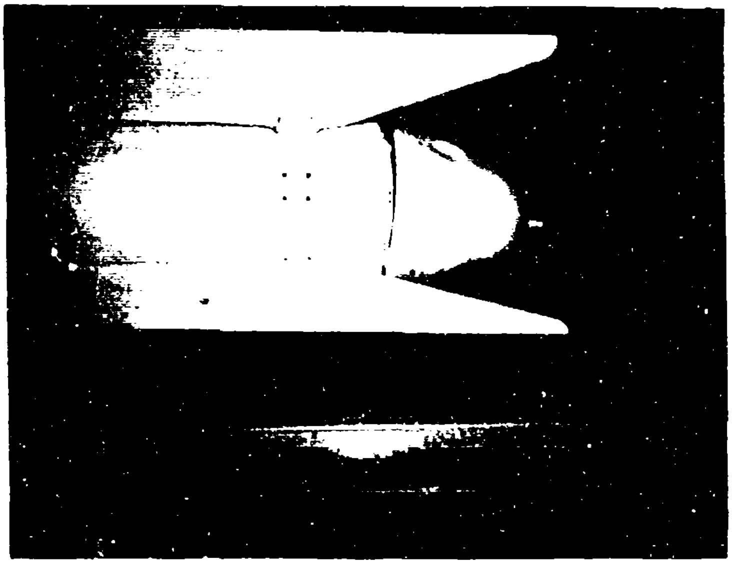

Figure 17. Displaced Tail Cap

12. The repeat vibration test, with the redesigned tail section, showed that the parachute can assembly, which had been modified after the earlier tests, withstood the vibration. However, two discrepancies in the bomb were noted.

a. The tail section became misaligned with the center section during the vertical axis vibration. Slippage at the joint between the center section and the tail section accounted for the misalignment. It is believed that slippage was allowed by the presence of paint on the seating surfaces of the bolts holding the tail section to the center section.

b. The insert carrying the lanyard for releasing the tail cap became unscrewed early in the vibration and fell away from the bomb.

SECTION III

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS

a. Performance of this bomb under atmospheric environmental and static load conditions is satisfactory for the conditions specified.

b. The lanyard feedthrough insert installation is not sufficiently rigid for the vibration specified.

c. Care is necessary in attaching the tail section to the center section and the tail cap to the tail section to avoid possible shifting of parts under vibration and shock.

2. RECOMMENDATIONS

a. The lanyard feedthrough installation should be locked to prevent rotation during vibration.

b. Particular attention during field testing should be given to the tail cap and tail section so that any shifting of these parts may be promptly corrected.

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
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13. ABSTRACT

(Distribution Limitation Statement No. 2)

A sample preproduction model of the BDU-41/B practice bomb was weighed and its center of gravity determined. It was then subjected to temperature, humidity, salt fog, shock, vibration, and static load tests to determine suitability for production. Test results were satisfactory except that vibration tests revealed weaknesses which requi required some redesign of the bomb.

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